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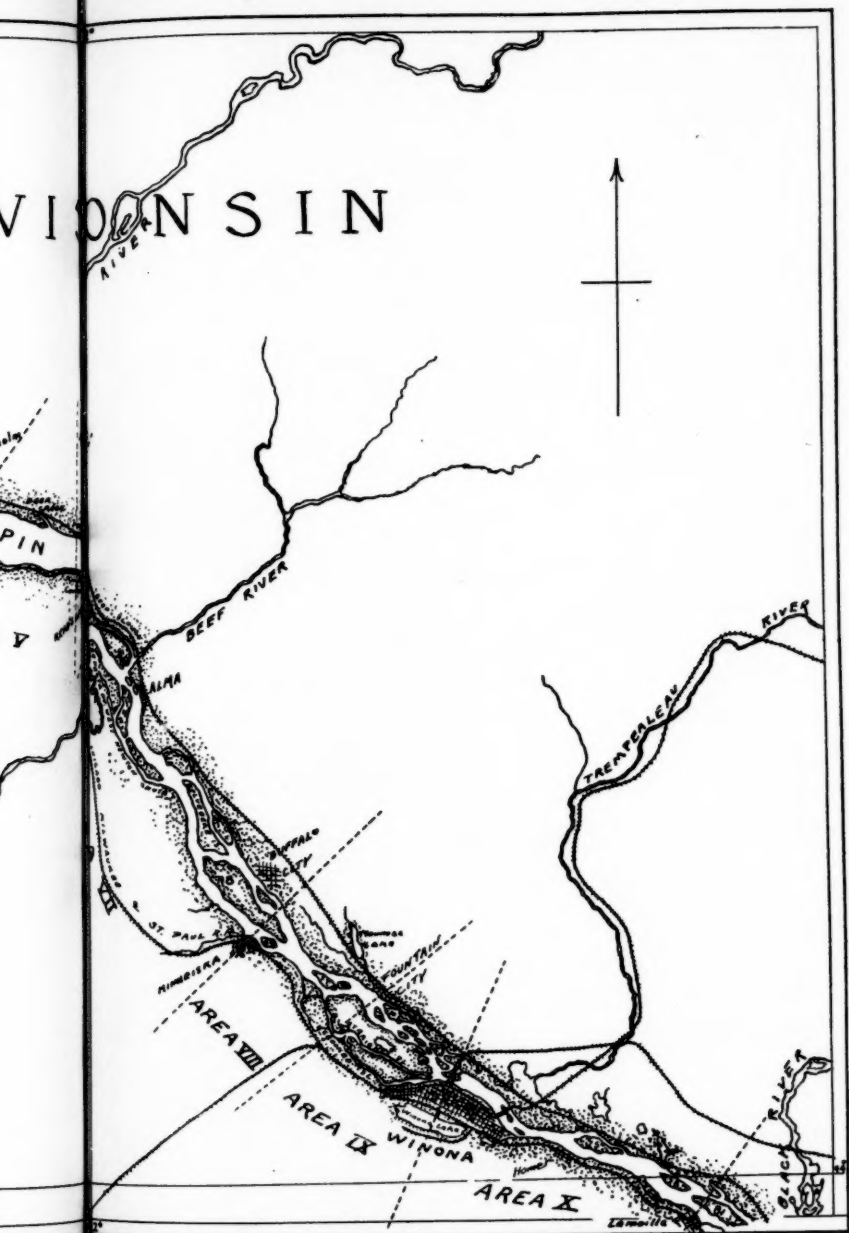
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NO. 1.

Final Report on the Study and Appraisal of Mussel Resources in Selected Areas of the Upper Mississippi River.*

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Washington, Pa.

I. INTRODUCTION.

During the months of July and August, 1920, the U. S. Bureau of Fisheries made a study and appraisal of the mussel resources of the Mississippi River in and between the areas commencing at a point about five miles above Red Wing, Minnesota, extending thence through Lake Pepin, and ending nearly 80 miles down stream at La Moille, Minn. More exact boundaries for the areas will be indicated hereafter. The work carried on was with reference to recent administrative action on the part of the states of Wisconsin and Minnesota, which provided for the closure of certain of these areas for the protection of the fresh water mussels, as well as for areas to remain subject to fishery. From the data acquired in this investigation, it is expected to establish a basis for comparison of conditions in the present and after a period of protection.

II. GENERAL CONDITIONS IN THE AREAS.

While usually attaining a depth of from 5-20 ft. within the limits of the state of Minnesota, the river at the time of this investigation was in a flood stage of from 2-9 ft. One apparent effect of the latter condition was to cause a migration of the mussels shoreward, as in general the outer limits of the shell beds are often determined by the deeper waters of the channel. The fall of the river is greater below L. Pepin than

* Published with the authorization of the U. S. Commissioner of Fisheries. Contribution from the Fairport Biological Station.

† During this investigation, Messrs. J. F. Mueller and W. Teachout served as assistants.

above it, resulting in a more rapid current in the former region, which is accelerated by the pressure of the impounded waters of the Lake. Where snags are abundant on the bottom, this current is strong enough to make mussel fishing with crowfoot bars somewhat dangerous.

The bottom of the river within the areas is for the most part composed of fairly coarse gravel mixed with varying proportions of mud and sand.* The latter increase perceptibly in the vicinity of the tributary streams of the region, the principal entering streams being the Cannon River at Red Wing, the Chippewa at Read's Landing, the Zumbro near Wabasha, Minn., and the Trempealeau below Winona, Minn. The Chippewa is principally responsible for the enormous quantities of sand brought into these areas discussed below Lake Pepin. Only through the construction of wing dams have the Government engineers been able to preserve a navigable channel. These dams are designed to catch the sand near mid-stream, deflecting it toward the shore where it ultimately forms sand bars or islands, but unfortunately smothering at the same time the valuable clam beds which formerly existed in the Mississippi below Lake Pepin, with the consequent discouragement of the clamming industry. In the opinion of some engineers, it appears practicable to terrace the banks of the Chippewa near Lake Pepin in such a way as to divert the sand to fill up the low lying country nearby, but a better preventative would be the reforestation of the Chippewa drainage basin. The conservation of the national mussel resources in thus seen to be closely related to other problems of national economy.

III. STATUS OF THE MUSSEL FISHERIES IN RELATION TO THE PRECEDING.

That stretch of the river about five miles northwest of Red Wing in the vicinity of Diamond Island, and which is known to old-time clammers as the Trenton Bed, is apparently but little worked, although our observations indicate that such might be profitably undertaken as it is in an area subject to fishery. At Red Wing itself the summer, of the survey, three clammers were observed. They reported that their returns seemed to be diminishing, although in past years this immediate section was considered one of the best on the river.

As will be observed in the accompanying tables, certain species, commercial as well as non-commercial, have been clammed out of this as well as other localities, some trace of them always being found in the piles of shells observed along the bank, or old clammers remembered collecting them in the vicinity.

Within the area studied, the clamming center of the river is in that part of Lake Pepin between Lake City and Pepin, as in late years the profitable downstream limit of the mussel fishery in these areas has been found to be the outlet of Lake Pepin about $1\frac{1}{2}$ miles northwest of Read's Landing in an area which has since been closed to clamming. Lake Pepin furnishes most of the shells from the areas considered, but its clam resources appear to be attracting but few fishermen. Where in 1914, 100 rigs were observed in operation on the lake, hardly more than 15 were working in the summer of 1920. However, it is stated on good authority, (a), that about 200 tons of mussel shells, with an average valuation of from \$50 to \$55 per ton had their source in this region. The best pearl found sold for \$750, a half dozen others brought from \$100 to \$175.

South of Lake Pepin during August, 1920, but two other clammers were seen, one rig at Winona, Minn., and a solitary clammer working with a fork in the nearby Straight Slough, obtaining only scanty returns. Piles of dead shells on the banks of the latter indicated the former abundance of the mussel fauna. At one time there existed extensive mussel beds at or near Wabasha, Minn., Teepeeota Point, (about 4 miles downstream from the former); near Alma and Fountain City, Wis.; Minneiska and Winona, Minn. The party found greater or smaller remnants of these formerly worked beds. They appear to be composed of old and sometimes gigantic shells, with an absolute dearth of younger ones. This would indicate that the beds are not being maintained, even if bottom conditions generally are favorable for mussel life. If it were found practicable to restock such beds with juvenile shells, such beds might readily regenerate. Reasons commonly assigned within the last mentioned regions for the de-

(a) A well informed manufacturer writes "As near as we are able to estimate, there have been between 200-250 tons of shells collected on the Mississippi River between St. Paul and Winona during 1920, and inasmuch as Lake Pepin is the center of the clamming industry, we believe that 80% of the total amount would represent the quantity taken from Lake Pepin and close vicinity.

pletion of the mussels resources, and the consequent decline of the clamming industry may be given:

1. The smothering of the mussel beds by sand deflected by the dams has been previously indicated. Additionally it may be stated that the increased current thereby insured has the probable effect of sweeping juveniles just dropped from fish long distances down stream, or to lodge them upon the sand bars, where later they may be covered up.

Within the limitations of the apparatus used in this investigation, it was not found practicable to estimate quantitatively the extent of the mussel beds smothered in this fashion. Under such circumstances, the dead shells were difficult to collect by the prevalent method of clamming. To indicate that such beds were formerly extensive are the statements of fishermen as corroborated by the observation of government engineers. Mention is made further on of those beds which came under the party's observation.

2. Destructive fishing methods formerly in use, such as taking very young shells, deliberately clamming out beds, or fishing with the shoulder rake, are also responsible. The party found evidence of the latter in most of the beds last mentioned. However, favorable sentiment toward respecting this part of the protective laws is widely prevalent.

3. The growth of formerly extensive mussel beds near communities situated along the river has been inhibited by the pernicious practice of dumping rubbish of somewhat indestructible nature in the river at those points. While state laws are also clear upon this point, the enforcement of them seems largely a matter of local sentiment.

The remnants of the clam beds at Alma, Fountain City, and Minneiska, appear to be the ones affected in this way. The appraisal work here was unusually difficult due to the fouling of the collecting apparatus on such obstructions as slag, old iron, etc., in the water. From the economic standpoint, the least which may be granted is that such rubbish has the effect of rendering the mussels but difficultly accessible to the fisherman, and he is inclined to let such beds alone. Such mussel resources are therefore not utilized. On the other hand, it is recognized that materials such as sand, coal,

cinders, ashes, logs, decaying wood, bark, sawdust, as were often encountered, have a distinctly injurious effect upon fish when dumped into the water. This is important, when it be remembered that fish carry the larval young of the mussels about with them. Such a combination may account for the scarcity of young shells in the beds, or tend to render the environment a more difficult one to combat, whatever be the more direct reason.

As the situation is today, the sand bars created by the dams may, following certain conditions such as flood or drought, harbor mussels in sufficient abundance as to make their taking by hand fairly profitable. Characteristically abundant and commercial species found on such sand bars are the three-ridge and blue-point, (*Quadrula olicata* and *undulata*), pig-toe, (*Quadrula undata*), pocketbook, (*Lampsilis ventricosa*), with lesser quantities of the pimple back, (*Quadrula pustulosa*), hickory nut, (*Obovaria ellipsis*), and monkey face, (*Quadrula metanevra*). Most of these shells, especially the pocket books, were of an excellent quality for button making.

In many cases the mussels, especially the younger ones inhabiting the sand bars, were observed to be dying in large numbers as the result of their inability to move with the water as it fell from the flood stages. The utilization of the mussel resources below Lake Pepin therefore seems to demand that the mussels be taken from the sandbars by hand when desirable for commercial purposes, and that the stranded animals be given the conserving care such as fish receive in rescue work. By way of experiment, the party stocked two sections of an area in which mussels were nearly absent, but in which conditions seemed quite favorable, with younger shells of various species, collected from the sand bars, where, by the way, shells are more abundantly taken by hand than from the bottom by crowfoot bars.

While the sloughs are dammed off from the river for the ultimate purpose of draining them, they are as rich, if not richer in mussels than the main river. Excellent examples of sloughs with a richer fauna are the Belvedere and Straight Sloughs, and the West Newton Chute. In all these, shells were collected by hand or by crowfoot bars. Work

with the latter in deeper portions of Straight Slough and West Newton Chute in their lower stretches, revealed the fact that young beds of shells of commercial quality were flourishing under conditions which might be favorable for restocking, despite the ultimately desired effect of the dams, as the sloughs are to some extent fed with local drainage. Piles of shells at these points indicated the extent of former clamming operations. Certain species, such as the bull head, (*Pleurobema aesopsus*), as we collected it, apparently find their most congenial environment here. Shells collected from the sloughs appear to have brighter colors and a finer grain than those secured from the river proper.

When the preceding data on general conditions in the areas and the status of the mussel fisheries are considered in entirety, it becomes evident that before the mussel resources of these areas can be improved, some practicable basis must be determined, from which measures looking forward to the protection and the improvement of the mussel resources can be inaugurated. This is all the more important when it is remembered that the states of Wisconsin and Minnesota are pioneers in the legislation for the protection of mussel resources, it is quite likely that other states will enact similar measures. The reason for this study and appraisal of mussel resources in certain areas of Wisconsin and Minnesota thus becomes clear.

IV. METHODS.

(a.) Description of outfit for collection of shells.

The work was approached from the standpoint of the mussel fisherman, a bar and crowfoot outfit being used to collect the shells. The outfit was towed from place to place by a Government Launch. In the areas above Lake Pepin, (I-VI. inc.,) 100 hooks were attached to each of the 16-ft. bars. Below Lake Pepin, starting at Read's Landing, (areas VII.-X. inclus.), the river bottom is heavily infested with snags, so the bars were shortened to 10 ft., with a consequent reduction in the number of hooks on each to 75. In the first named areas, the data presented represents the results of three trials of the same length of drag with the bars, (300 ft.) at each of the localities, (those to be checked five years hence), in-

icated. In the remaining areas, the number of drags was increased from 3 to 4, to compensate for the reduction in the number of hooks, but otherwise the procedure was the same.

Additionally, the john-boat had at its bow, a hand windlass bearing 300 ft. of stout, ($\frac{5}{8}$ in.) line, to the free end of which an anchor was attached. In proceeding from locality to locality, the windlass was locked, and the boat towed by a separate piece of line. Two separate dredgings were also made of the bottom of the river in each locality, proceeding from the same initial point. The dredge used consisted of a heavy rectangular frame work of iron about 18 in. in length, 6 in. in breadth, at the mouth, and 6 in. in height. To it was fastened a large and very closely woven net with the capacity of about a bushel, and with meshes varying from 1-16 to $\frac{1}{8}$ in. The net was protected by a canvas cover attached at one end to the iron framework, and open at the other. Ropes, $\frac{1}{2}$ in. were attached to iron rings on the shorter side of the frame work, and these lead forward to a single rope 50 ft. in length, secured in the stern of the john-boat. The longer and outer edges of the iron framework were provided with coarse, triangularly shaped teeth, 4 in. in length, while the mouth was guarded by 4-5 stout iron wires, running vertically to the longer axis of the iron framework and spaced about 3 in. apart. The teeth provided for the dislodgement of shells and other materials from the bottom of the river, while the guards around the mouth prevented the ingress of very large gravel or other objects. Additionally, the length of rope with which it was attached, provided for reaching the greatest depth of bottom, while after the dredge was lifted, and the attached rope drawn in about 4-5 of its length, the launch could speed up, and thus most of the mud and sand obscuring the contents of the dredge washed away. By means of the dredge, a fair idea of conditions on the bottom of the particular locality could be determined. Such data would later be useful in connection with propagation experiments.

(b). Collecting Mussels for study and appraisal.

When it was determined to appraise a particular locality, a starting point was determined by methods shortly to be described, the windlass and the tow-line were released, and

the launch going ahead unreeled the 300 ft. of line into the water until it was very nearly taut, when the operator of the launch dropped the anchor, at the free end. For the purpose of temporarily anchoring the john-boat while the line was being payed out, one of the bars, usually that one to be placed to the rear, was at favorable opportunity, dropped into the water in such a way that it laid at right angles with the shore, and dragged parallel to it. When it had touched bottom, it was secured into position by means of props and by knotting its rope around one of the uprights. As shortly thereafter as the boat had swung into a favorable position as to render less liable the entangling of the hooks of the bars, the remaining bar was dropped and secured likewise.

After the anchor was dropped and the bars properly played, one of the two operators in the john-boat, windlassed the latter by slow and steady turns up to the point where the anchor had been dropped, observing from time to time the relative apparent motion of the shore line to make certain that snagging or fouling of the bars was not causing the john-boat to pull the anchor towards it in the meantime. When such was found to be the case, the bars were pulled up, the catch discarded, and a new trial made. When the john-boat had been properly windlassed up to the anchor, the latter and the bars were pulled up, the mussels taken off the hooks and thrown into a tub. The launch then towed the john-boat back to the original starting place, when this procedure was repeated twice again for each locality, the mussels obtained from the 3 trials being counted together. Dead shells obtained were not recorded.

The use of the dredge has already been indicated to some extent. Mature mussels caught in it were included among those obtained as previously described. The residue of the net was then examined. After the gravel and larger biological specimens which could be easily seen were removed by hand, the remainder was then screened in the water through sieves of varying fineness, until the juvenile mussels which were especially sought could be picked out by hand. Juveniles were also obtained from masses of water weed pulled up by the crowfoot bars and the dredge. The larger number of them

were obtained from the water weed, to which they were attached by their byssus thread. The dredge had the disadvantage of being apt to foul on some obstruction, and was besides very unwieldy, being apt to hinder the progress of the work. Juveniles taken were at once preserved in a mixture of 4 per cent formalin, 70 per cent alcohol and shell dust, the latter substance preventing erosion of the shell by the other chemicals. They were labelled, counted, and shipped to the Fairport Biological Station. The number obtained at each locality is expressed in parenthesis after the number of mature mussels obtained there; upon the sum of the two at any locality all calculations are made. Other biological specimens were at early opportunity shipped to the various specialists for identification, and the results of their work, which is hereby gratefully acknowledged, is comprised in the notes on the various areas.

(c). Determination of localities.

The course of the river was followed by means of a set of maps of the river published by the Mississippi River Commission, and by a copy of the current edition of the light list for the 13th Lighthouse District as in use by navigators on the river. The position of each locality surveyed is indicated on the maps used, which are now in possession of the U. S. Biological Station, Fairport, Iowa. On these maps, the localities are numbered according to area, and to the order in which they were examined. Thus 1-3 on the map indicates Area 1 and the third locality in it. Reference to the data to follow are to be similarly understood. As previously indicated, only the three best localities in each Area are reported upon.

It was not found practicable to draw into the maps these localities on an exact scale. The markings largely indicate the relative position of the locality with regard to the shore line at the time, the more absolute one being obtained by reference to the descriptive material given in connection with the markings on the maps. The more absolute data concerning the position of the locality was obtained by reference to some object or formation along the shore which seemed of a fairly permanent nature, such as the Government Lights or

Day Marks or other improvements along the river, ravines, elevation of adjacent hills, clumps of bushes, trestles, etc. The first 2 types of reference points were not used when anything better could be observed. The light list referred to gives the distances of these markers and lights from more accurately defined points such as bridges, etc. As data furnished by local clammers was sometimes found to be misleading, positions of productive shell beds were frequently determined by a trial drag with a single bar at varying distances from the shore, when, after encouraging results, the three consecutive drags with both bars were attempted. All beds of shells of fair extent which the party encountered are also indicated upon the maps mentioned.

Once the reference point was established, the distance across the water of the starting point of the drag from this was estimated independently by the three members of the party. The average taken of these distances is that one given in the descriptive material of the localities, and in case of great varieties in estimate, the more probable distance was verified by measurement of other points on the map within sight, and by the making of comparisons. A map case of the type used in the U. S. Army, provided with compass and transparent waterproof cover was found to be a convenient carrier for the maps in the field, where the localities could be promptly indicated. A leather-bound notebook of the type used by engineers was found to be serviceably adaptable for the recording of data. It should be borne in mind, however, that as the larger portion of the work was accomplished under conditions of high water, it was difficult to accurately estimate the position of the normal shore line, and the distances given are those of the position of the outfit from the nearest land above water at the time.

V. LIST OF SPECIES COLLECTED.

The following list embraces those species of mussels collected within the areas surveyed. Besides indicating the common name by which the mussels are known to clammers, the older scientific names of Simpson's Descriptive Catalogue of the Naiades are given, and their equivalent in the forth-

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coming Pilsbry-Ortman-Walker nomenclature, which follows more closely the rules of modern zoological nomenclature.

COMMON NAME	SCIENTIFIC NAME	
<i>Commercial Species</i>	After Simpson	After Ortman
Niggerhead	<i>Quadrula ebenus</i>	<i>Fusconaja ebena</i> (Lea.)
Niggerhead	<i>Quadrula solida</i>	<i>Pleurobema catillus</i> (Con.)
Hickory Nut	<i>Obovaria ellipsis</i>	<i>Obovaria olivaria</i> (Raf.)
Pimple Back	<i>Quadrula pustulosa</i>	<i>Quadrula pustulosa</i> (Lea.)
Maple Leaf	<i>Quadrula lachrymosa</i>	<i>Quadrula quadrula</i> (Raf.)
Monkey Face	<i>Quadrula metanevra</i>	<i>Quadrula metanevra</i> (Raf.)
Purple Pimple Back	<i>Quadrula tuberculata</i>	<i>Rotundaria granifera</i> (Lea.)
Three Horn Warty Back	<i>Obliquaria reflexa</i>	<i>Obliquaria reflexa</i> (Raf.)
Pig Toe	<i>Quadrula undata</i>	<i>Fusconaja undata</i> (Barnes.)
Blue-Point	<i>Quadrula plicata</i>	<i>Amblema peruviana</i> (Lam.)
Three-Ridge	<i>Quadrula undulata</i>	<i>Amblema costata</i> (Raf.)
Wash Board	<i>Quadrula heros</i>	<i>Megalonaia heros</i> (Say.)
Buck Horn	<i>Tritogonia tuberculata</i>	<i>Quadrula verrucosa</i> (Raf.)
Mucket	<i>Lampsilis ligamentina</i>	<i>Actinonails carinata</i> (Barnes.)
Higgin's Eye	<i>Lampsilis higginii</i>	<i>Lampsilis higginii</i> (Lea.)
Lake Pepin Mucket	<i>Lampsilis luteola</i>	<i>Lampsilis siliquioidea</i> (Barnes.)
Butterfly	<i>Plagiola securis</i>	<i>Plagiola lineolata</i> (Raf.)
Deer Toe	<i>Plagiola elegans</i>	<i>Amygdalonaia truncata</i> (Raf.)
Pocket Book	<i>Lampsilis ventricosa</i>	<i>Lampsilis ventricosa</i> (Barnes.)
Yellow Sand Shell	<i>Lampsilis anodontoides</i>	<i>Lampsilis anodontoides</i> (Lea.)
Slough Sand Shell	<i>Lampsilis fallaciosa</i>	<i>Lampsilis fallaciosa</i> (Smith.)
Black Sand Shell	<i>Lampsilis recta</i>	<i>Eurynia recta</i> (Lam.)
Bull Head	<i>Pleurobema aesopus</i>	<i>Pleurobema cyphus</i> (Raf.)
(No Common Name)	<i>Lampsilis subrostrata</i>	<i>Eurynia subrostrata</i> (Say.)
White Hell Splitter	<i>Symphynota complanata</i>	<i>Lasmigona complanata</i> (Barnes.)
Fluted Shell	<i>Symphynota costata</i>	<i>Lasmigona costata</i> (Raf.)
Pink Heel Splitter	<i>Lampsilis alata</i>	<i>Prostera alata</i> (Say.)
Rock Pocket Book	<i>Arcidens confragosus</i>	<i>Arcidens confragosus</i> (Say.)
Elephant Ear	<i>Unio erassidens</i>	<i>Elliptio niger</i> (Raf.)
Spike	<i>Unio gibbosus</i>	<i>Elliptio dilatatus</i> (Raf.)
Ohio River Pig Toe (?)	<i>Pleurobema pyramidatus</i>	<i>Pleurobema pyramidatum</i> (Lam.)
Elk Toe	<i>Alasmidonta marginata</i>	<i>Alasmidonta marginata</i> (Say.)
Sugar Spoon	<i>Plagiola donaciformis</i>	<i>Amygdalonaia donaciformis</i> (Lea.)

NON-COMMERCIAL SPECIES *

Slop Bucket	<i>Anodonta grandis</i>	<i>Anodonta grandis</i> (Say.)
Paper Shell	<i>Anodonta corpulenta</i>	<i>Anodonta corpulenta</i> (Cooper.)
Squaw Foot	<i>Anodonta imbecillis</i>	<i>Anodonta imbecillis</i> (Say.)
Faer Shells	<i>Strophitus edentulus</i>	<i>Strophitus edentulus</i> (Say.)
	<i>Lampsilis gracilis</i>	<i>Leptodea fragilis</i> (Raf.)
	<i>Lampsilis laevisima</i>	<i>Prostera laevisima</i> (Lea.)
Snuff Box	<i>Lampsilis parva</i>	<i>Carunculina parva</i> (Barnes.)
Floater	<i>Truncilla triquetra</i>	<i>Truncilla triquetra</i> (Raf.)

VI. RESULTS.

These include data compiled upon the absolute and relative abundance of each species of mussel found in the areas appraised, together with such geographical or other information likely to be of use in expediting the rechecking of these results after a period of protection, or which might have a bearing upon propagation experiments. The number of shells of each species collected in each locality is given under the heading of the latter, and the percentage of this in the total catch in the locality is indicated. The average of the three percentages thus obtained for each species in each area is taken to

represent the relative abundance of that species in the area. An asterisk, (*), indicates that the species was found to be less than 1 per cent in the area and locality involved. A blank space opposite the name of a species indicates that living shells were not collected in either the area or the localities of it.

AREA I.

Boundaries; lower half of Diamond Island, Miss. R. to Red Wing, Minn., at High Bridge. Status, subject to fishery. Length in Linear Miles, 4.2. Physical Conditions, estimated 7-8 ft. high water. Current about 5 miles per hour. Bottom mostly gravel and sand. Middle sections of area infested with snags.

LOCALITIES REPORTED UPON. (ref. maps.)

I—1. Starting point of drags Govt. Day Mark 958-n near center of Diamond Island, 25 ft. from shore on Minnesota side of channel. July 7, 1920.

I—2. Starting point of drags Govt. Day Mark 958-k, (above island 23), Wisconsin side of channel, 30 ft. from shore, about 1/2 mile down stream from preceding locality.

I—6. Starting point of drags, 300 ft. upstream from Govt. Day Mark 958-g across the mouth of slough about 1 mile above Red Wing on Minnesota side, 50 ft. from mouth of slough. July 9, 1920.

COMI
Fusco
Pleuro
Obova
Quadr
Quadr
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Rotun
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Fusco
Amble
Amble
Megal
Quadr
Actino
Lamps
Lamps
Plagio
Amygo
Lamps
Lamps
Euryon
Euryon
Pletho
Lasmi
Lasmi
Propte
Areide
Ellipti
Ellipti
Pleuro
Alasmi
Amygo
TO

Anodor
Anodor
Anodor
Stroph
Leptod
Propte
Carunc
Trunc
TO
TOTAL

clam
said
Pepin

NOTES ON AREA.

Certain species, as *E. dilatatus*, *B. granifera*, are at present

AREA I.

COMMERCIAL SPECIES *	Locality 1-1	% Total Catch in Locality	Locality 1-2	% Total Catch in Locality	Locality 1-6	% Total Catch in Locality	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>	7	1.5%	1	*	1	*	*
<i>Pleurobema catillus</i>	3	*	3	*	1	*	*
<i>Obovaria olivaria</i>	133	30%	141	34%	5	1.9%	21.9%
<i>Quadrula postulosa</i>	23	5%	7	*	1	*	2.5%
<i>Quadrula quadrula</i>	7	1.5%	6	1.4%	1	*	*
<i>Quadrula metanевра</i>	7	1.5%	7	1.7%	1	*	1.66%
<i>Rotundaria granifera</i>	10	2.2%	4	*	1	*	1.5%
<i>Obliquaria reflexa</i>	7	1.5%	3	*	1	*	*
<i>Fusconaja undata</i>	11	2.4%	3	*	1	*	1%
<i>Amblema peruviana</i>	14	*	3.4%	4	1.5%	1.6%	*
<i>Amblema costata</i>	10	2.2%	3	*	1	*	*
<i>Megalonais heros</i>	9	2%	3	*	1	*	*
<i>Quadrula verrucosa</i>	26	5.9%	46	11.2%	12	4.7%	7.3%
<i>Actinonais carinata</i>	1	*	1	*	1	*	*
<i>Lampsilis higginsii</i>	18	4%	6	1.4%	32	12.5%	5.9%
<i>Lampsilis siliquoidea</i>	1	*	1	*	1	*	*
<i>Plagiola lineolata</i>	17	3.8%	5	1.2%	29	11.2%	1.6%
<i>Amygdalona truncata</i>	51	11.9%	44	10.9%	3	2.1%	11%
<i>Lampsilis ventricosa</i>	1	*	1	*	1	*	*
<i>Lampsilis anodontoides</i>	9	2%	16	3.9%	4	1.9%	*
<i>Lampsilis fallaciosa</i>	1	*	1	*	1	*	*
<i>Eurynia recta</i>	1	*	1	*	1	*	*
<i>Eurynia subrostrata</i>	1	*	1	*	1	*	*
<i>Plethobasus cyphus</i>	18	4%	2	*	1	*	1.4%
<i>Lasmigona complanata</i>	23	5.2%	14	3.4%	1	*	2.8%
<i>Lasmigona costata</i>	1	*	3	*	1	*	*
<i>Proptera alata</i>	7	1.5%	6	1.4%	1	*	1%
<i>Arcidens confragosus</i>	1	*	3	*	1	*	*
<i>Elliptio niger</i>	1	*	3	*	1	*	*
<i>Elliptio dilatatus</i>	7	1.5%	6	1.4%	1	*	1%
<i>Pleurobema pyramdatum</i>	1	*	1	*	1	*	*
<i>Alasmidonta marginata</i>	3	*	1	*	1	*	*
<i>Amygdalonais donaciformis</i>	3	*	1	*	1	*	*
TOTALS	395	8.66%	336	73.7%	94	33.9%	63%
NON-COMMERCIAL SPECIES *							
<i>Anodonta grandis</i>	1	*	12	2.9%	48	19%	6.3%
<i>Anodonta corpulenta</i>	1	*	12	2.9%	69	29%	10.6%
<i>Anodonta imbecillis</i>	12	2.7%	35	8.5%	5	1.9%	4.3%
<i>Strophitus edentulus</i>	11	*	1	*	4	*	*
<i>Leptodea fragilis</i>	17	3.8%	15	3.6%	34	13.6%	7%
<i>Proptera laevissima</i>	17	4%	1	*	1	*	*
<i>Carunculina parva</i>	1	*	1	*	1	*	*
<i>Truncilla trquetra</i>	1	*	1	*	1	*	*
TOTALS	47	10.5%	62	15.6%	161	65.4%	28.2%
TOTALS ALL SHELLS	442	97.1%	408	89.3%	255	99.3%	91.2%

clammed out of this area. Two large piles of these shells, said to have come from this region were observed in Lake Pepin. Indications are that this area constitutes a metropolis

for *O. olivaria*, although the largest shells of this species were obtained at Wabasha. *A. corpulenta* of the river at this point seems to be much thicker than the same species as obtained from the sloughs. Locality I-2 is known to old time clammers as the Trenton Bed. While still fairly productive, no clammers were observed working it at this time. Juveniles were comparatively rare in this area.

AREA II.

Boundaries, Red Wing, Minn., to Bay City, Wis. Status, closed to fishery. Length in Linear Miles, 5.8. Physical Conditions, 7 ft. high water; current about 3 miles per hour; bottom mostly sand and mud; snags most abundant toward the Wisconsin shore. Water weed in lower stretches.

LOCALITIES REPORTED UPON. (ref. maps.)

II—1. Starting point of drags 300 ft. upstream off Wisconsin shore from Govt. Day Mark 958-e, on edge of main channel about 40 ft. from shore. July 10, 1920.

II—2. Starting point of drags 35 ft. from shore, about $\frac{1}{4}$ mile downstream from Govt. Day Mark 958-d, opposite bathing houses and summer camp on Minn. shore. July 10, 1920.

II—4. Starting point of drags 100 ft. downstream from Govt. Day Mark 958-b, 45 ft. from Minnesota shore.

NOTES ON AREA.

Collecting in this area was best on the edge of the channel. It was extensively clammed some years ago. At present, there appear to be fewer shells of the *Quadrula* group than others. *Truncilla triquetra* was first recorded from the upper region of the river at this point. Juveniles, especially of *Anodonta* and *Lampsilis* sp. are more abundant here than in the preceding area.

AREA II.

COMMERCIAL SPECIES *	Locality II-1	% Total Catch in Locality	Locality II-2	% Total Catch in Locality	Locality II-4	% Total Catch in Locality	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>	1	*	1	*	1	*	*
<i>Pleurobema catillus</i>	1	*	2	1%	5	1.6%	1%
<i>Obovaria olivaria</i>			47	23.5%	32 (4)	11.8%	12%
<i>Quadrula postulosa</i>			7	3.5%	8	2%	1.8%
<i>Quadrula quadrula</i>			7	3.5%	3	1%	1.5%
<i>Quadrula metanevra</i>			3	1.5%	2	*	*
<i>Rotundaria granifera</i>							1.3%
<i>Obliquaria reflexa</i>			8	4%			2.6%
<i>Fusconaja undata</i>			2	*	19	6.2%	3.1%
<i>Amblerma peruviana</i>							*
<i>Amblerma costata</i>	1	*			27	8.9%	*
<i>Megalonaia heros</i>							2.3%
<i>Quadrula verrucosa</i>					4	1.3%	5.1%
<i>Actinonais carinata</i>			1	*	20	6.6%	*
<i>Lampsilis higrinsii</i>							16%
<i>Lampsilis siliquioidea</i>	18	6.6%	9	4.5%	13	4.2%	*
<i>Plagiola lineolata</i>					1	*	1.7%
<i>Amygdalonaia truncata</i>					3	1.5%	*
<i>Lampsilis ventricosa</i>	49 (5)	19.9%	54	27%	6	1.9%	*
<i>Lampsilis anodontoides</i>			2	1%			*
<i>Lampsilis fallaciosa</i>							9.9%
<i>Eurynia recta</i>	1 (1)	*	1	*	13	4.2%	*
<i>Eurynia subrostrata</i>							*
<i>Plethobasus cyphus</i>					4	1.3%	*
<i>Lasnigona complanata</i>	1	*					*
<i>Lasnigona costata</i>							7.9%
<i>Proptera alata</i>	56 (1)	21%	2	1%	24	7.9%	1.9%
<i>Arcidens confragosus</i>					6	1.9%	*
<i>Elliptio niger</i>							*
<i>Elliptio dilatatus</i>					2	*	*
<i>Pleurobema pyramidatum</i>							*
<i>Alasmidonta marginata</i>							*
<i>Amygdalonaia donaciformis</i>					1	*	*
TOTALS.....	134	47.5%	149	72%	195	60.8%	58.9%

NON-COMMERCIAL SPECIES *

<i>Anodonta grandis</i>	20	11.9%	17	8.5%	15	5.1%	8.5%
<i>Anodonta corpulenta</i>	33 (2)	12.4%	17	8.5%	16	5.1%	8.6%
<i>Anodonta imbecillis</i>					13	4.3%	1.4%
<i>Strophitus edentulus</i>					8	2%	*
<i>Leptodea fragilis</i>	25 (1)	28%	14	7%	15	5%	13%
<i>Proptera laevissima</i>					36	11.9%	3.9%
<i>Carunculina parva</i>							*
<i>Truncella triquetra</i>	2	*			1	*	*
TOTALS.....	133	52.3%	48	24%	104	33.4%	35.4%
TOTALS ALL SHELLS.....	267	99.9%	197	96%	299	94.2%	89.2%

AREA III.

Bounderies, Bay City, Wis. to Maiden Rock, Wis., and Frontenac, Minn. Status, subject to fishery. Length in Linear Miles, 5.7. Physical Conditions, 7 ft. high water; current about 2 miles; bottom, gravel, mud, and some sand. Comparatively free from snags. Water weeds fairly common in upper stretches of area.

LOCALITIES REPORTED UPON. (ref. maps.)

III—1. Lake Pepin, starting point of drags 1,500 ft. towards point with Light 957 from Wacouta Point, Minn., 100 ft. from shore, starting at a clump of low willows. July 14, 1920.

III—4. About 2 miles below Bay City on Wisconsin shore, starting at a clump of willows and poplars at lower end of promontory with an altitude of 680. Drags 75 ft. off shore July 15, 1920.

III—8. Drags from Point No-Point to Frontenac Point in a straight line between them, starting 300 ft. from shore of first, and finishing 75 ft. from shore of second. July 16, 1920.

NOTES ON AREA.

In this section of Lake Pepin there exist clam beds known from their adjacent regions as the Maiden Rock and Warren-ton Beds. After poor success here, we learned from clam-mers, that while this was ordinarily a good locality, it was at this time covered with 6 in. of decaying vegetable matter brought in by the unusual rains of the summer, and this prevented the hooks from taking hold. Juveniles were somewhat less abundant than in the preceding area.

During the entire period of our collecting in Lake Pepin, and less noticeably so in the lower stretches of the river, there was observed on the surface of the lake, masses of algal plankton occurring in the form of dots, short rods and tendrils. Messrs. H. W. Clark and R. S. Corwin of the Fairport Biological Station state additionally concerning it, "the alga is practically all *Aphanizomenon flos-aquae*. It is predominant in the plankton algae of the Upper Mississippi. It is abundant in Lake Pokegama also. There were one or two colonies of *Anabaena spiroides* and one *Diffugia cratera* in the mass examined."

The abundance of such plant food in Lake Pokegama and Lake Pepin may account in some degree for the abundance and excellent quality of the fat muckets found in those Lakes. Fresh water sponge was abundant on the Minnesota side of the lake.

AREA III.

COMMERCIAL SPECIES *	Locality III-1	% Total Catch in Locality	Locality III-4	% Total Catch in Locality	Locality III-8	% Total Catch in Locality	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Pleurobema catillus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Obovaria olivaria</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Quadrula postulosa</i>	3	3.5%	5	6.5%	.....	.....	3.3%
<i>Quadrula quadrula</i>.....	.....	.....	2	2.6%	.....	.....	.....
<i>Quadrula metanevra</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Rotundaria granifera</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Obliquaria reflexa</i>	2	2.4%	1	1.3%	.....	.....	.....
<i>Fusconaja undata</i>	5	5.9%	8	10.4%	14	14.9%	10.4%
<i>Amblema peruviana</i>.....	.....	.....	3(1)	5.2%	11	11.7%	5.9%
<i>Amblema costata</i>	8	9.5%	8(1)	11.7%	3	3.2%	8.1%
<i>Megalomus heros</i>.....	.....	.....	4	5.2%	.....	.....	1.7%
<i>Quadrula verrucosa</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Actinonais carinata</i>.....	.....	.....	2	2.6%	.....	.....	.....
<i>Lampsilis bigginsii</i>.....	.....	.....	1	1.3%	.....	.....	.....
<i>Lampsilis siliquioidea</i>	32(1)	39.2%	5	6.5%	33(4)	39.5%	28.4%
<i>Plagiola lineolata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Amygdalona truncata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis ventricosa</i>	3	3.5%	4	5.2%	1	1%	3.2%
<i>Lampsilis anodontoides</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis fallaciosa</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Euryxia recta</i>	1	1.2%	1	1.3%	.....	.....	1%
<i>Euryxia subrostrata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Plethobasus cyphus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lasmigona complanata</i>.....	.....	.....	2	2.6%	1	1%	1.2%
<i>Lasmigona costata</i>	1	1.2%	.....	.....	.....	.....	.....
<i>Proptera alata</i>	5	5.9%	13	16.9%	10	10.7%	11.2%
<i>Arcidens confragosus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Elliptio niger</i>.....	.....	.....	1	1.3%	.....	.....	.....
<i>Elliptio dilatatus</i>	8	9.5%	5	6.5%	1	1%	7.3%
<i>Pleurobema pyramidatum</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Alasmidonta marginata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Amygdalona donaciformis</i>.....	.....	.....	.....	.....	.....	.....	.....
TOTALS.....	70	83%	67	86.8%	83	83.3%	84.7%

NON-COMMERCIAL SPECIES *

<i>Anodonta grandis</i>	9	10.5%	2	2.6%	.....	.....	4.4%
<i>Anodonta corpulenta</i>	2	2.4%	6	7.8%	5	5.3%	5.2%
<i>Anodonta imbecillis</i>	2	2.4%	.....	.....	(1)	1%	1.2%
<i>Strophitus edentulus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Leptodea fragilis</i>.....	.....	.....	2	2.6%	2	2.1%	1.6%
<i>Proptera laevis</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Carunculina parva</i>	1	1.2%	.....	.....	.....	.....	.....
<i>Truncilla triquetra</i>.....	.....	.....	.....	.....	.....	.....	.....
TOTALS.....	14	16.5%	10	13%	10	10.5%	13.5%
TOTALS ALL SHELLS.....	89	16.5%	77	100%	93	98.8%	98.2%

AREA IV.

Boundaries, Maiden Rock, Wis., and Frontenac, Minn. to Lake City, Minn. and Stockholm, Wis. Status, closed to fishery. Length in Linear Miles, 6.7. Physical Conditions, 5 ft. high water; bottom varying from pebbles, to sand and mud; current $1\frac{1}{2}$ to 2 miles per hour. Patches of water weed abundant.

LOCALITIES REPORTED UPON. (ref. maps.)

IV—9. Opposite Mrs. Coles estate, starting at point between brown barn and white house at 700 ft. elevation, 65 ft. from shore, proceeding toward bend. July 19, 1920.

IV—11. Along Lake City Park front, starting at a poplar tree in front of fishermen's shanty, proceeding downstream toward bend in stone wall. 250 ft. off shore. July 20, 1920.

IV—12. At Lake City, between Lake City Point Light and breakwater, starting 40 ft. off shore, from center of space between small house and ice-house. July 20, 1920.

NOTES ON AREA.

Clammers believe this area to be pretty well clammed out, although it contained more juvenile shells than previously encountered in other areas. This fact seems reasonably due to the propagation experiments which the Bureau of Fisheries has been conducting in the region for several years. This area really produces the larger number of juveniles than any other considered, but as adult shells from these localities are in the great minority, the juveniles are not represented in the check localities given. All data submitted for juveniles is from the standpoint of their frequency in clam beds, whereas below Lake Pepin they were found to be most abundant on the sand bars. The juveniles were mostly *L. siliquioidea*. The water weeds encountered were *Vallisneria spiralis*, *Ceratophyllum demersum*, and various species of *Potamogeton*. The party gained the impression that the abundance of juveniles in an area was related to the abundance of the water weed. Species of fresh water snails, and a crayfish collected were determined by Dr. A. E. Ortmann to be *Campeloma suboli-*

dum (Anthony) species of *Goniobasis* and *Pleurocera*, while the crayfish was *Cambarus* (*Faxonus*) *virilis*, Hagen.

AREA IV.

COMMERCIAL SPECIES *	Locality IV-9	% Total Catch in Locality	Locality IV-11	% Total Catch in Locality	Locality IV-12	% Total Catch in Locality	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>							
<i>Pleurobema castillus</i>							
<i>Obovaria olivaria</i>	1	*	(1)	*	1	*	
<i>Quadrula pustulosa</i>			3	1.2%	3	1.2%	1%
<i>Quadrula quadrula</i>			1	*	1	*	
<i>Quadrula metanevra</i>			1	*		*	
<i>R-tundaria granifera</i>							
<i>Obliquaria reflexa</i>							
<i>Fusconaja undata</i>	3	1.3%	2	*	1	*	
<i>Amblema peruviana</i>	32	14.4%	57	24.5%	19	8%	15.6%
<i>Amblema costata</i>	36	16.2%	17	7.3%	27	11.6%	11.7%
<i>Megalonaia heros</i>							
<i>Quadrula verrucosa</i>							
<i>Actinonais carinata</i>							
<i>Lampsilis higinisii</i>	88 (1)	40%	91	37%	102 (5)	46.4%	41.1%
<i>Lampsilis siliquioidea</i>							
<i>Placida lineolata</i>	3	1.3%	2	1%			
<i>Amygdalonaia truncata</i>	5	2.2%	17	7.3%	19	8.1%	5.8%
<i>Lampsilis ventricosa</i>							
<i>Lampsilis anodontoides</i>	2	*					
<i>Lampsilis fallaciosa</i>	4	1.8%	2	1%	4	1.7%	1.5%
<i>Eurynia recta</i>							
<i>Eurynia subrostrata</i>							
<i>Plethobasus cyphus</i>							
<i>Lasmigona complanata</i>	1	*	1	*	3	1.2%	1%
<i>Lasmigona castata</i>			(1)	*			
<i>Proptera alata</i>	11	4.9%	12	5.1%	7	3%	4.3%
<i>Areidens confragosus</i>							
<i>Elliptio niger</i>	3	1.3%	6	2.6%	16	6.9%	3.6%
<i>Elliptio dilatatus</i>							
<i>Pleurobema pyramdatum</i>							
<i>Alasmidonta marginata</i>							
<i>Amvedalonaia donaciformis</i>	1 (3)	1.8%	2	*	3	1.2%	1%
TOTALS.....	195	85.2%	216	87%	211	90%	86.6%

NON-COMMERCIAL SPECIES *

<i>Anodonta grandis</i>	8	3.6%	5	2.1%	9	3.8%	3.2%
<i>Anodonta corpulenta</i>	13	5.8%	(1)	*	(6)	2.6%	2.8%
<i>Anodonta imbecillis</i>	4	1.8%	6	2.6%	3 (1)	1.7%	2%
<i>Strophitus edentulus</i>			1	*			
<i>Leptodea fragilis</i>			2	1%			
<i>Proptera laevisima</i>			1	*	2	*	
<i>Carunculina parva</i>	1	*	1	*	1	*	
<i>Truncella triquetra</i>							
TOTALS.....	26	11.2%	17	5.9%	22	8%	8%
TOTALS ALL SHELLS.....	221	96.4%	233	92.7%	233	98%	94.6%

AREA V.

Boundaries, Lake City, Minn. and Stockholm, Wis. to Pepin, Wis. Status, subject to fishery. Length in Linear Mile, 5.3. Physical Conditions, 5 ft. high water during survey; current two miles per hour; bottom mud and sand with a few pebbles; occasional patches of water weed.

LOCALITIES REPORTED UPON. (ref. maps.)

V—5. Off Lake City shore near hospital, starting opposite first tree on bank north of hospital, 120 ft. from shore. July 23, 1920.

V—6. Below Camp Grounds, (southeast of Lake City), starting at point adjacent to 900 elevation, (Asplund's farm), at distance 15 ft. from shore. July 24, 1920. Minnesota shore.

V—10. About $1\frac{1}{4}$ miles from Deer Lake, (Wisconsin shore), and $\frac{1}{4}$ mile from pier at Pepin, starting point at nearest house on Wisconsin shore with 2 outbuildings in the rear. 600 ft. off shore.

NOTES ON AREA.

Compared with adults, juveniles were more abundant here than in any other area. This area was the one most worked in Lake Pepin during the summer of 1920, and some valuable pearls had their origin here. While fresh water sponges had been encountered from the beginning of the trip, such were more abundant in Lake Pepin than elsewhere. Specimens collected and forwarded to Professor Frank Smith, University of Illinois, were identified as *Spongilla fragilis*, Loidy.

AREA V.

COMMERCIAL SPECIES *	Locality V-5	% Total Catch in Locality	Locality V-6	% Total Catch in Locality	Locality V10	% Total Catch in Locality	Average % Catch in 3 Localities
<i>Fuseonaja ebena</i>			15	3.7%	6	2.4%	*
<i>Pleurobema catillus</i>							*
<i>Obovaria olivaria</i>	1	*			2	*	*
<i>Quadrula postulosa</i>					1	*	*
<i>Quadrula quadrula</i>			1	*	1	*	*
<i>Quadrula metanevra</i>							*
<i>Rotundaria granifera</i>							*
<i>Obliquaria reflexa</i>	4	1.4%	7	1.7%	1	*	1%
<i>Fusonaja undata</i>	40 (0)	17%	73 (2)	18.7%	55 (3)	23.2%	19.6%
<i>Ambleria peruviana</i>	30 (4)	11.9%	2 (4)	1.5%	21	8.4%	7.3%
<i>Ambleria costata</i>			59	14.7%			4.9%
<i>Megalomais heros</i>							*
<i>Quadrula verrucosa</i>	1	*					*
<i>Actinonais carinata</i>							*
<i>Lampsilis higginsii</i>	104 (20)	43.4%	108 (13)	30.2%	69 (4)	29%	34.2%
<i>Lampsilis silicoidea</i>							*
<i>Plagiola lineolata</i>					2	*	1%
<i>Amygdalona truncata</i>	20 (3)	8%	44 (6)	10.7%	45 (5)	18%	12.3%
<i>Lampsilis ventricosa</i>					1	*	*
<i>Lampsilis anodontoides</i>	3	1%			1	*	*
<i>Lampsilis fallaciosa</i>	1	*	8	2%	2	*	1.5%
<i>Eurynia recta</i>							*
<i>Eurynia subrostrata</i>			1	*			*
<i>Plethobasus cyphus</i>					2	*	1%
<i>Lasmigona complanata</i>	5	1.7%	1	*			*
<i>Lasmigona costata</i>							*
<i>Proptera alata</i>	5	1.7	11	2.7%	10	4%	2.8%
<i>Arcidona confragosus</i>							*
<i>Elliptio niger</i>	18	6.3%	20	5%	10 (1)	4.4%	5.2%
<i>Elliptio dilatatus</i>							*
<i>Pleurobema pyramidatum</i>							*
<i>Alasmidonta marginata</i>							*
<i>Amygdalona donaciformis</i>	3	1%	2	*			*
TOTALS.....	272	93.4%	386	92.4%	241	89.4%	89.8%

NON-COMMERCIAL SPECIES *

<i>Anodonta grandis</i>	5	1.7%	4	1%	2	*	1.2%
<i>Anodonta corpulenta</i>	1	*	1	*	(1)	*	*
<i>Anodonta imbecillis</i>	4	1.4%	6	1.5%			1%
<i>Strophitus edentulus</i>					3	1.2%	*
<i>Leptodea fragilis</i>							*
<i>Proptera laevis</i>							*
<i>Carunculina parva</i>							*
<i>Truncilla triquetra</i>							*
TOTALS.....	10	3.1%	11	2.5%	6	1.2%	2.2%
TOTALS ALL SHELLS.....	282	96.5%	397	94.9%	247	90.6%	92%

AREA VI.

Boundaries, Pepin and King's Coulee to Read's Landing, Minn. Status, closed to fisheries. Length in linear Miles, 4. Physical conditions, 4 ft. high water; current about 2 miles. Bottom, mud and sand, with a great deal of water weed on the Wisconsin side. Cobbles, gravel, and riff-raff on the Minnesota shore.

LOCALITIES REPORTED UPON. (ref. maps.)

VI—3. Starting point, 700 ft. north of point marked 682.09 and 673.42 on map, at foot of Lake Pepin, 500 ft. off shore. July 27, 1920.

VI—5. Starting point 1,000 ft. southwest C. M. & St. P. R. R. trestle at culvert opposite Knud Johnston's Coulee, (1760 elevation), 150 ft. from shore. July 28, 1920.

VI—6. One mile upstream from bridge at Read's Landing, 300 ft. s. w. of C. M. & St. P. R. R. at base of stone quarry, 700 ft. from Minnesota shore. July 28, 1920.

NOTES ON AREA.

Next to Area V, the juveniles found were most abundant here. Locality 6 in this area represents a re-juvenating bed at the base of Lake Pepin, clammed out years ago, and at that time producing many niggerheads. The only living specimen of *R. granifera* taken in the lake was secured at this place, although previously large numbers of dead shells were seen. At this point there was collected for the first time, *Pleurobema Poyramidatum*. Both localities 5 and 6 had comparatively few old shells in them. Locality 3 is shunned by clammers on account of the rocky bottom at this place, yet certain clammers who know the region are able to make good hauls here. Juveniles were fairly abundant. Specimens of *Plagiola lineolata* were particularly large. Fresh water sponges, and Bryozoa of species to be later given were also obtained here.

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AREA VI.

COMMERCIAL SPECIES *	Locality VI-3	% Total Catch in Locality	Locality VI-5	% Total Catch in Locality	Locality VI-6	% Total Catch in Locality	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>.....	.....	.....	.....	.....	16	3.6%	1.2%
<i>Pleurobema catillus</i>.....	.....	.....	.....	.....	7 (1)	1.8%	*
<i>Obovaria olivaria</i>.....	.....	.....	.....	.....	13	2.9%	1%
<i>Quadrula postulosa</i>.....	.....	.....	2	*	5	1.1%	*
<i>Quadrula quadrula</i>	3	2%	3	*	.....	.....	2%
<i>Quadrula metanevra</i>	1	*	1	*	23	5.2%	2%
<i>Rotundaria granifera</i>.....	.....	.....	.....	.....	1	*	*
<i>Obliquaria reflexa</i>.....	.....	.....	2	*	8	1.8%	1%
<i>Fusconaja undata</i>	6 (1)	4%	138	28.9%	22	5%	12.6%
<i>Amblema peruviana</i>	5 (2)	4.8%	51 (1)	10.9%	66	15%	10.3%
<i>Amblema costata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Megalonaia heros</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Quadrula verrucosa</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Actinonaias carinata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis higginsii</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis siliquoides</i>	33 (4)	25.5%	92 (9)	21.2%	53 (3)	12.8%	19.8%
<i>Plagiola lineolata</i>.....	.....	.....	3	*	9	2%	1%
<i>Amygdalonaia truncata</i>.....	.....	.....	5 (3)	1.6%	16 (3)	4.3%	1.9%
<i>Lampsilis ventricosa</i>	53 (5)	40%	26 (5)	6.5%	31 (6)	8.5%	18.3%
<i>Lampsilis anodontoides</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis fallaciosa</i>.....	.....	.....	.....	.....	2	*	*
<i>Eurynia recta</i>	8	5.5%	9	1.8%	2	*	3.2%
<i>Eurynia subrostrata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Plethobasus cyphus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lasmigona complanata</i>	4	2.9%	4	*	4	*	1.4%
<i>Lasmigona costata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Proptera alata</i>	4	2.7%	21	4.4%	21	4.8%	3.9%
<i>Areidens confragosus</i>.....	.....	.....	.....	.....	1	*	*
<i>Elliptio niger</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Elliptio dilatatus</i>	5	3.4%	74	15.5%	75	17.2%	12%
<i>Pleurobema pyramidatum</i>	2	*	.....	.....	.....	.....	*
<i>Alasmidonta marginata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Amygdalonaia donaciformis</i>.....	.....	.....	.....	.....	3	*	.....
TOTALS.....	132	90.6%	449	90.8%	391	86%	88.6%

NON-COMMERCIAL SPECIES *

<i>Anodonta grandis</i>.....	.....	.....	.....	.....	.....	.....
<i>Anodonta corpulenta</i>	6	4.1%	.....	.....	7	5.6%
<i>Anodonta imbecillis</i>	(1)	*	10	2.1%	.....	3.2%
<i>Strophitus edentulus</i>	1	*	.....	.....	5	1.1%
<i>Leptodea fragilis</i>	1 (1)	1.3%	5 (2)	1.4%	21 (1)	5%
<i>Proptera laevisissima</i>.....	.....	.....	.....	.....	.....	2.6%
<i>Carunculina parva</i>.....	.....	.....	.....	.....	.....	.....
<i>Truncella triquetra</i>.....	.....	.....	.....	.....	.....	.....
TOTALS.....	10	5.4%	17	3.5%	34	11.7%
TOTALS ALL SHELLS.....	142	96%	466	94.3%	425	97.7%

AREA VII.

Boundaries, Read's Landing, Minn., to Minneiska, Minn. Status, open to fishery. Length in Linear Miles, 20.9. Physical conditions, 5 ft. high water; current 4-6 miles per hour. Bottom, sandy, with many i-bedded snags, especially in upper portion.

LOCALITIES REPORTED UPON. (ref. maps.)

VII—4. 320 ft. upstream from Government Light 946, along water front at Wabasha, 49 ft. from shore. July 31, 1920.

VII—6. Teepeeota Point, 350 ft. west of willows at the point, 150 ft. from shore line. July 31, 1920.

VII—14. Off Alma, Wis., starting 50 ft. north of R. E. Jones' Mill, 40 ft. from shore. August 3, 1920.

NOTES ON AREA.

Few juveniles were to be seen in this area. On the site of an old shipyard at Wabasha, remnants of a clam bed with some young shells were found. The bed is hindered in regeneration by the amount of rubbish, iron wire, etc., dumped in the locality. The same conditions hold for locality VII-4. Further down at Teepeeota point was a remnant, composed of gigantic shells of an old clam bed, in which juveniles were totally absent. The bottom in this locality seemed well suited to mussel growth, there being no rubbish, few if any snags. The current has probably carried away the juveniles. Much effort was expended in this and other areas to locate clam beds by the method already described, but most of the productive ones have been covered up. There are few if any water weeds in this area except in the sloughs.

In the vicinity of Alma, (Govt. Light 926 and the R. E. Jones Mill), other remnants of beds exist, composed of giant "niggerheads" and "warty backs." Only a slight idea could be gained of these latter, as the bottom was so snaggy that it was unprofitable to attempt work with the crowfoot bars. Formerly this bed was worked with a pitch fork. At the lower limits of this area shells were more abundant, and were more easily secured from sand bars than any place else. The upper portion of West Newton Chute was very prolific in this respect. Species of snails and crayfish as recorded previously were common here.

AREA VII.

COMMERCIAL SPECIES *	Locality VII-4	% Total Catch in Locality.	Locality VII-6	% Total Catch in Locality.	Locality VII-14	% Total Catch in Locality.	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>	10	6.3%	3	2.1%	2	7%	2.3%
<i>Pleurobema catillus</i>.....	.....	.....	3	5.8%	1	3.8%	4.3%
<i>Obovaria olivaria</i>.....	.....	.....	7	4.9%	4	15.4%	7%
<i>Quadrula postulosa</i>	1	4.4%	1	*	5	19.8%	9.7%
<i>Quadrula quadrula</i>.....	.....	.....	.....	.....	.....	.....	*
<i>Quadrula metanevra</i>	20	12.6%	.....	.....	7	26.9%	13.2%
<i>Rotundaria granifera</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Obliquaria reflexa</i>.....	.....	.....	3	2%	1	3.8%	1.9%
<i>Fusconaja undata</i>	11	6.9%	7	4.9%	1	3.8%	5.2%
<i>Amblema peruviana</i>.....	.....	.....	15	10.6%	1	3.8%	4.8%
<i>Amblema costata</i>	17	10.7%	3	2%	.....	.....	4.2%
<i>Megalonaia heros</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Quadrula verrucosa</i>	5	3.1%	6	4.2%	1	3.8%	3.7%
<i>Actinonais carinata</i>	33	20%	.....	.....	.....	.....	6.6%
<i>Lampsilis higginsii</i>.....	.....	.....	3	2.1%	.....	.....	.....
<i>Lampsilis silivoides</i>.....	.....	.....	1	*	.....	.....	*
<i>Plagiola lineolata</i>	2	1.2%	1	*	.....	.....	*
<i>Amygdalonaia truncata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis ventricosa</i>	14	8.8%	46	32.6%	1	3.8%	15.1%
<i>Lampsilis anodontoides</i>	1	*	1	*	.....	.....	*
<i>Lampsilis fallaciosa</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Eurynia recta</i>	20	12.6%	8	5.6%	.....	.....	8.3%
<i>Eurynia subrostrata</i>.....	.....	.....	.....	.....	2	7.7%	2.5%
<i>Plethobasus cyphus</i>.....	.....	.....	.....	.....	.....	.....	*
<i>Lasmigona complanata</i>.....	.....	.....	4	2.8%	.....	.....	.....
<i>Lasmigona costata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Proptera alata</i>	2	1.2%	9	6.3%	.....	.....	3.3%
<i>Arceidens confragosus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Elliptio niger</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Elliptio dilatatus</i>	8	5%	7	4.9%	.....	.....	4.4%
<i>Pleurobema pyramidatum</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Alasmidonta marginata</i>	2	1.2%	.....	.....	.....	.....	*
<i>Amygdalonaia donaciformis</i>.....	.....	.....	.....	.....	.....	.....	.....
TOTALS.....	153	94%	133	90.6%	26	99.2%	96.5%

NON-COMMERCIAL SPECIES *

Anodonta grandis.....						
Anodonta corpulenta.....						
Anodonta imbecillis.....						
Strophitus edentulus.....	2	1.2%	1	*		1%
Leptodea fragilis.....	1	*	3	2.1%		1%
Proptera laevisima.....	2	1.2%	4	2.8%		1.3%
Carunculina parva.....						
Truncilla triquetra.....						
TOTALS.....	5	2.4%	8	4.9%		3.3%
TOTALS ALL SHELLS.....	158	96.4%	141	95.5%	26	99.2%
						99.8%

AREA VIII.

Boundaries, Minneiska, Minn. to Fountain City, Wis. Status, closed to fishery. Length in Linear Miles, 10.8. Physical Conditions, 2 ft. high water; current about 2 miles per hour. Bottom, sand, mud, cobbles, mud, riff-raff, and infested with snags.

LOCALITIES REPORTED UPON. (ref. maps.)

VIII—1. Starting at Govt. Light 902.35 ft. off shore, south of island 4. August 11, 1920.

VIII—10. One-half mile around the bend from Govt. Light 896.35 ft. off shore, starting point adjacent to coulee south of Chimney Rock. August 14, 1920.

VIII—19. Straight Slough, 100 ft. south of the north of the first large slough leading from it, (at upper end) to the C. M. & St. P. R. R. tracks from 655 elevation; on opposite shore at distance 20 ft. from banks. August 16, 1920.

NOTES ON AREA.

This area stands third in the abundance of juveniles found. Remnants of a bed were found along the water front at Minneiska. This is given in locality VIII-1. Locality VIII-10 represents the old Chimney Rock Bed. Juveniles secured in this and succeeding areas were obtained from sand bars principally by hand.

In this area, there were frequently collected upon the sand bars crayfish which Dr. A. E. Ortmann of the Carnegie Museum, Pittsburgh, Pa., pronounced to be *Cambarus (Eaxohus) virilis* Hagen, (males of the second form,) and *Cambarus blandingii acutus* Gerard, (males of the second forms).

As early as the latter part of July there was noticed a brilliant bluish-green scum upon the shore of the sloughs and sand bars. Some of the material was sent to Dr. G. T. Moore, director of the Missouri Botanical Garden for identification. Dr. Moore stated it "was a mixture of 3 blue-green algae, the major portion being *Clathrocystis serrigensa*, with occasional colonies of *Coelosphaerium kuetzingianum*, as well as occasional colonies of *Anabaena flos-aquae*. This mixture is a very common one and has been associated for a number of years with the phenomemon known abroad as the "breaking of the meres." In this country it is generally referred to as the "flowering of the waters."

Dr. C. B. Davenport, of the Carnegie Station for Experimental Evolution, Cold Spring Harbor, N. Y., identified specimens of Bryozoa forwarded him as *Pectinatella magnifica*. These were collected from Fountain City Bay, Fountain

City, Wis. He indicates that the following additional species may be expected to occur in the Mississippi also, viz. *Urnatella gracilis*, *Paludicella ehrenbergii*, *Fredericella sultana*, *Cristatella macedo* and various species of *Plumatella*. Some of these species are known from the Illinois River, and on account of the resistance which the statoblasts have to the digestive fluids of birds, have become widely distributed over the whole country east of the Rocky Mountains.

AREA VIII.

COMMERCIAL SPECIES *	Locality VIII-1	% Total Catch in Locality.	Locality VIII-10	% Total Catch in Locality.	Locality VIII-19	% Total Catch in Locality.	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>	33	21.4%	.....	.....	.....	.....	7.1%
<i>Pleurobema catillus</i>	33	14.3%	.....	.....	.....	.....	4.7%
<i>Obovaria olivaria</i>.....	.....	.....	.....	.....	3 (1)	4.2%	1.4%
<i>Quadrula postulosa</i>.....	.....	.....	1	8.3%	1	1%	2.8%
<i>Quadrula quadrula</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Quadrula metanevra</i>	1	7.1%	.....	.....	.....	.....	2.3%
<i>Rotundaria granifera</i>.....	.....	.....	1	.....	.....	.....	.....
<i>Obliquaria reflexa</i>.....	.....	.....	1	8.3%	.....	.....	2.8%
<i>Fusconaja undata</i>.....	.....	.....	6	50%	12	12.6%	2.1%
<i>Amblera peruviana</i>.....	.....	.....	1	8.3%	10	10.5%	11%
<i>Amblera costata</i>	33	14.2%	.....	.....	.....	.....	4.7%
<i>Megalomais heros</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Quadrula verrucosa</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Actionais carinata</i>	1	7.1%	.....	.....	.....	.....	2.3%
<i>Lampsilis higginsi</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis siliquioidea</i>.....	.....	.....	.....	.....	1 (10)	11.5%	3.8%
<i>Plagiola lineolata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Amygdalona truncata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis ventricosa</i>.....	.....	.....	1	8.3%	30 (15)	4.7%	18.4%
<i>Lampsilis anodontoides</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lampsilis fallaciosa</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Eurynia recta</i>	1	7.1%	1	8.3%	.....	.....	5.1%
<i>Eurynia subrostrata</i>.....	.....	.....	.....	.....	1	1%	.....
<i>Plethobasus cyphus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Lasmigona complanata</i>.....	.....	.....	1	8.3%	.....	.....	2.7%
<i>Lasmigona costata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Proptera alata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Arcidens confragosus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Elliptio niger</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Elliptio dilatatus</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Pleurobema pyramidatum</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Alasmidonta marginata</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Amygdalona donaciformis</i>.....	.....	.....	.....	.....	.....	.....	.....
TOTALS.....	12	85.4%	12	100%	84	87.8%	90.1%

NON-COMMERCIAL SPECIES *

<i>Anodonta grandis</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Anodonta corpulenta</i>	2	14.2%	.....	.....	1	1%	5%
<i>Anodonta imbecillis</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Strophitus edentulus</i>.....	.....	.....	.....	.....	5 (3)	8.4%	3%
<i>Leptodea fragilis</i>.....	.....	.....	.....	.....	1	1%	.....
<i>Truncella triquetra</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Proptera laevisima</i>.....	.....	.....	.....	.....	.....	.....	.....
<i>Carunculina nana</i>.....	.....	.....	.....	.....	.....	.....	.....
TOTALS.....	2	14.2%	12	100%	11	11.4%	8%
TOTALS ALL SHELLS.....	14	99.6%	12	100%	95	99.2%	98.1%

AREA IX.

Boundaries, Fountain City, Wis. to Winona, Minn. (High Bridge). Status, open to fishery. Length Linear Miles, 8.6. Physical Conditions, 2 ft. high water; current 4 miles. Bottom, gravel and mud, with less amount of riff-raff than in preceding areas.

LOCALITIES REPORTED UPON. (ref. maps.)

IX—2. South end of Island 62, across the mouth of a slough, starting 20 ft. from nearest shore. Aug. 18, 1920.

IX—22. Straight Slough, about 3 miles from mouth, across the mouth of the first slough above island with 655 elevation. 25 ft. from north shore. Aug. 21, 1920.

IX—31. 800 ft. northwest of the N. W. R. R. bridge at Winona, 35 ft. from sheer boom. Aug. 23, 1920.

NOTES ON AREA.

An old bed of "niggerheads" existing at Wild's Landing was found to be absolutely covered with sand deflected by the dams. No trace of a bed said to exist in the vicinity of Island 55 was found. The best collecting in this area was from the sandbars, and in the lower portion of the area we frequently encountered very large specimen of *Anodonta grandis*. Many stranded pocketbooks, (*Lampsilis ventricosa*) were found cut open for pearls, presumably by the foreign element of the population of Winona.

Locality IX-22 is in the upper portion of Straight Slough near Winona. At the present time it is a flourishing bed, indicating that conditions are favorable here for mussel growth. Fresh water snails, (*Pleurocera acuta*, Raf.) and a form of *Sphaerium stamineum* Conrad, as determined by Dr. Bryant Walker, were abundant here.

AREA IX.

COMMERCIAL SPECIES *	Locality IX-2	Total Catch In Locality.	Locality IX-22	Total Catch In Locality.	Locality IX-31	Total Catch In Locality.	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>			15	28.5%	7	3.4%	13%
<i>Pleurobema catillus</i>					2	1%	
<i>Obovaria olivaria</i>	1	3.5%	2	3.8%	13	6.3%	4.5%
<i>Quadrula postulosa</i>			1	1.9%	8	3.9%	1.9%
<i>Quadrula quadrula</i>			7	13.3%	49	23.8%	12.5%
<i>Quadrula metanevra</i>							
<i>Rotundaria granifera</i>							
<i>Obliquaria reflexa</i>					1	*	*
<i>Fusconaja undata</i>	1	3.5%	6	11.4%	26	12.7%	9.2%
<i>Amblema peruviana</i>			2	3.8%	3	1.4%	1.4%
<i>Amblema costata</i>							
<i>Megalonais heros</i>					4	1.9%	*
<i>Quadrula verrucosa</i>					7	3.4%	1%
<i>Actinonais carinata</i>							
<i>Lampsilis higginsii</i>							
<i>Lampsilis siliquioidea</i>	3	10.7%					3.5%
<i>Plagiola lineolata</i>							
<i>Amygdalonnais truncata</i>			3	5.7%	4	2%	1%
<i>Lampsilis ventricosa</i>	3 (5)	28%	4	7.6%	18	8%	14.6%
<i>Lampsilis anodontoides</i>							
<i>Lampsilis fallaciosa</i>	7	24.5%					8%
<i>Eurynia recta</i>			3	5.7%	14	6.8%	4.2%
<i>Eurynia subrostrata</i>							
<i>Plethobasus cyphus</i>			2	5.8%	8	3.9%	3.1%
<i>Lasmigona complanata</i>	1	3.5%					1%
<i>Lasmigona costata</i>							
<i>Proptera alata</i>					1	*	*
<i>Arcidenis confragosus</i>							
<i>Elliptio niger</i>							
<i>Elliptio dilatatus</i>			1	1.9%	7	3.4%	1.8%
<i>Pleurobema pyramidatum</i>							
<i>Alasmidonta marginata</i>					3	1.4%	*
<i>Amygdalonnais donaciformis</i>	1	3.5%			3	1.4%	1.2%
TOTALS.....	22	77.2%	46	87.4%	180	86.1%	81.5%

NON-COMMERCIAL SPECIES *

<i>Anodonta grandis</i>							
<i>Anodonta corpulenta</i>	1	3.5%			1		1.5%
<i>Anodonta imbecillis</i>	1	3.5%					1%
<i>Strophitus edentulus</i>	1	3.5%	2	3.8%	15	7.4%	5%
<i>Leptodea fragilis</i>	3	10.7%	3	5.7%	8	3.9%	6.7%
<i>Proptera laevisissima</i>							
<i>Carunculina parva</i>							
<i>Truncilla triquetra</i>							
TOTALS.....	6	21.2%	5	9.5%	24	11.3%	13.7%
TOTALS ALL SHELLS.....	28	98.4%	51	96.9%	204	97.4%	95.2%

AREA X.

Boundaries, Winona, Minn. (high bridge) to La Moille, Minn. Status, closed to fishery. Length in Linear Miles, 7.2. Physical Conditions, 2 ft. high water; current 4 miles per hour; bottom, sand and gravel; many snags.

LOCALITIES REPORTED UPON. (ref. maps.)

X—4. Sheer boom, 450 ft. north of Burlington bridge at Winona; drags 15-25 ft. from edge off Minnesota shore. August 24, 1920.

X—6. Above Homer, starting opposite 700 ft. elevation and dragging down to point with 655 elevation; 25 ft. off Minnesota shore. August 25, 1920.

X—9. Starting at point adjacent to Homer at 680 elevation, 25 ft. from shore. August 25, 1920.

NOTES ON AREA.

Locality X-4 represents what appears to be a thriving and previously unworked bed of shells, extending beneath the Burlington bridge at Winona. While shells are fairly common at Homer Station, riff-raff on the bottom made their collection somewhat difficult. In the vicinity of Govt. Day Mark 851-a (840-86 elevation) the party planted 150 pigtoes, (*F. undata*), and 100 three ridges, (*A. peruviana*) in hopes of ultimately starting a bed there. Fresh water sponges and crayfishes of the identification already given were also collected at Homer.

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AREA X.

COMMERCIAL SPECIES *	Locality X-4	% Total Catch in Locality.	Locality X-6	% Total Catch in Locality.	Locality X-9	% Total Catch in Locality.	Average % Catch in 3 Localities
<i>Fusconaja ebena</i>	7	7.9%	7	4.9%	7	5.4%	6.1%
<i>Pleurobema catillus</i>	25	28.2%	9	1.4%	2	1.5%	1%
<i>Obovaria olivaria</i>	8	9%	3	6.3%	41	31%	21.8%
<i>Quadrula postulosa</i>	4	4.5%	25	2%	7	5%	5.3%
<i>Quadrula quadrula</i>	2	2.2%	15(2)	17.5%	13	13.2%	12%
<i>Quadrula metanevra</i>	12	13.5%	4	2.8%	6(1)	5.4%	3.6%
<i>Rotundaria granifera</i>	3	3.4%	9(1)	7.4%	6	4.6%	8.5%
<i>Obliquaria reflexa</i>	4	4.5%	4(1)	3.7%	1	*	2.8%
<i>Fusconaja undata</i>	2	2.2%	2	1.4%	2	1.5%	3.2%
<i>Amblema peruviana</i>	4	4.5%	3	2.2%	1	3.9%	3%
<i>Amblema costata</i>	1	1.1%	1	*	1	1.5%	*
<i>Megalonais heros</i>	15(1)	11.8%	16	12.4%	1	1.9%	1%
<i>Quadrula verrucosa</i>	1	1.1%	1	*	1	1.5%	1%
<i>Actinonais carinata</i>	5(1)	4.4%	5	3.9%	2	1.5%	2.7%
<i>Lampsilis higginsii</i>	3	2.1%	1	*	1	1.5%	1%
<i>Lampsilis siliquioidea</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Plagiola lineolata</i>	6(2)	5.9%	16	12.4%	1	1.5%	1.9%
<i>Amygdalona truncata</i>	1	1.1%	1	*	1	1.5%	1%
<i>Lampsilis ventricosa</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Lampsilis anodontoides</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Lampsilis fallaciosa</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Euryntia recta</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Euryntia subrostrata</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Plethobasus cyphus</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Lasmigona complanata</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Lasmigona costata</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Proptera alata</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Arcidens confragosus</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Elliptio niger</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Elliptio dilatatus</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Pleurobema pyramidatum</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Alasmidonta marginata</i>	5	5.6%	1	*	1	1.5%	1.9%
<i>Amygdalona donaciformis</i>	5	5.6%	1	*	1	1.5%	1.9%
TOTALS.....	79	87.2%	128	90%	121	91.8%	88.3%
NON-COMMERCIAL SPECIES *							
<i>Anodonta grandis</i>	2	1.4%	1	*	1	1.5%	1.2%
<i>Anodonta cerpulenta</i>	6	4.2%	2	*	2	1.5%	1.7%
<i>Anodonta imbecillis</i>	9	10.1%	4	2.8%	2	1.5%	4.6%
<i>Strophitus edentulus</i>	9	10.1%	4	2.8%	2	1.5%	4.6%
<i>Leptodea fragilis</i>	9	10.1%	4	2.8%	2	1.5%	4.6%
<i>Proptera laevisissima</i>	9	10.1%	4	2.8%	2	1.5%	4.6%
<i>Carunculina parva</i>	9	10.1%	4	2.8%	2	1.5%	4.6%
<i>Truncilla triquetra</i>	9	10.1%	4	2.8%	2	1.5%	4.6%
TOTALS.....	9	10%	14	8.4%	5	1.5%	7.5%
TOTALS ALL SHELLS.....	88	97.2%	142	98.4%	126	93.3%	95.5%

From the data presented under the title of each area, the following tabulation is made, dealing with the absolute abundance of shells in the areas appraised:

Area and Status as to Fishery	No. Shells Commercial Species per Linear Mile	No. Shells Non-Commercial Species per Linear Mile	Average All Shells per Linear Mile
I. Open -----	197.1	66	263.1
II. Closed -----	84.1	47.9	131.5
III. Open -----	39	5.61	44.61
IV. Closed -----	92	10.3	102.3
V. Open -----	166.8	7	173.8
VI. Closed -----	243.25	15.5	258.75
VII. Open -----	14.5 (16.13)	1 (6.55)	15.5 (22.68)
VIII. Closed -----	10. (43)	1.2 (2.8)	11.2 (45.8)
IX. Open -----	28.24 (54)	4.76 (7.6)	33. (61.6)
X. Closed -----	45.3 (62.91)	4 (8.3)	49.3 (71.24)

In the preliminary report of this survey, (p. 2) the data given on the absolute abundance of shells in Areas VII-X inclusive, was based in large part on collections of shells by hand from sand bars, as the latter embraced the larger number of best localities in the areas indicated. As it would be difficult to use such data in the future as a basis of comparison and rechecking, there has been substituted in this final report data obtained from other localities in these areas by the use of the bar and crowfoot outfit. Since it is felt that, due to the conditions described, that the latter represents the true absolute abundance of shells in the areas, there are added in parentheses to the above the results obtained from collecting by hand on the 3 best sandbars of these areas. For each of the 3 localities taken in account for each area, the data thus presented embodies the efforts of 3 men collecting by hand 30 minutes, a total consumption of 90 minutes time, and about that required to make 3 drags with the bars in any given locality. The results from the sandbars may be interpreted to represent the maximum of shells in the particular area.

VII. REMARKS AND RECOMMENDATIONS.

The tables given indicate that commercial species of mussels in the areas appraised are most abundant in the vicinity

of Red Wing, Minn., and in Lake Pepin. There is a decline in the number of the mussels in succeeding stretches of the river until the lower half of Lake Pepin is reached. Upon leaving the lake, a most marked diminution in their numbers occurs but on the other hand the absolute number of shells increases going down stream, showing that the necessary conditions for mussel life are present, and, on the whole, steadily improving. When it appears practicable to attempt the rehabilitation of the mussel beds below Lake Pepin, the following recommendations based upon the preceding information may receive consideration, viz:

1. Restoring old, but favorably situated beds in closed areas with advanced juveniles of commercial species. Such beds are those existing at the foot of Lake Pepin, Wabasha, Teepeeota Point, and those at Winona and Homer, Minn. If judged by the abundance of juveniles collected, the areas to be stocked in order are VI, VIII, IV.

2. Restocking and propagation of desirable species in certain sloughs, both in open and closed areas, as the young shells in the former case would be protected by the prevailing sentiment among mussel fishermen toward them. Sloughs offering some promise in this respect are the Belvedere below Minneiska, West Newton Chute near Alma, and the Straight Slough near Winona.

Corrections in Botanical Nomenclature.

OLIVER ATKINS FARWELL.

Dilepyrum erectum (Schreb.) N. comb. *Muhlenbergia erecta* Schreb., Besch. Gras. II 139. pl. 50 (1772-9). *Dilepyrum aristosum* Mx., Fl. Bor. Amer. 1:40 (1803).

Mr. A. S. Hitchcock, in The Genera of Grasses of the United States, (U. S. Dept. Agriculture Bulletin No. 772) p. 145, (1920) places the genus *Dilepyrum* Mx. as a synonym of *Muhlenbergia* Schreb. and remarks that either of Michaux's species are equally eligible as the type and that the second

D. minutiflorum is chosen in order to conserve the generic name *Brachyelytrum*. A careful examination of Michaux's generic description and application of same to his two species shows that "either" are not "equally eligible as the type." Michaux says: "*Valvis—subulato-lineatibus, carinatis,*" which is characteristic of his first species but not at all so of his second. Therefore as his generic description is more accurately descriptive of his first species, *D. aristosum*, than of his second, the former must be considered as the type of his genus. To arbitrarily adopt that species as a generic type which will permit of the reduction of an older name in order to conserve a later name is contrary to all botanical rules and codes, except, of course, where rules or codes specifically name such exceptions. Another reason why *D. aristosum* should be considered as the type, is that when *D. minutiflorum*, not considered as the type, is that when *D. minutiflorum*, not congeneric with the other, is removed to its proper genus, *Muhlenbergia*, published 12 years earlier, *D. aristosum* is the only species left in the genus and consequently, the type. *Brachyelytrum* Beauv., Ess. Agrost. 39, pl. 9, f. 2. (1812) must give way to the older *Dilepyrum* of Mx. under both the Vienna Rules and the American Code, Canon 15 of which requires that the 1st species, *D. aristosum*, be considered the generic type.

Gardenia, Colden, 1756; Boehmer in Ludw. Def. 292, 293 (1760). *Triadenum* Raf., Med. Rep. (2) V: 352 (1808); *Elodea* Adans, ex Juss., Gen. 255 (1789) and ex Pursh, Fl. Am. Sept. II 360, 379 (1814). *Gardenia* Ellis in philos. Trans. LI pt. 2, 935 (1761) becomes *Gardena* Adans. Fam. II 20 (1763).

Three species are known, native of eastern N. America, one extending through British America into n. e. Asia. They are as follows:

Gardenia Virginica (Linn) n. comb. *Hypericum Virginicum* Linn, Sp. Pl. (2) II 1104 (1763). U. S., east of the Rocky Mountains, n. and w. into Asia.

Gardenia longifolia (Small) n. comb. *Triadenum longifolium* Small in Bull. Torr. Bot. Club XXV 140 (1898)*. Florida and Alabama, northward to Kentucky.

Gardenia petiolata (Walt.) n. comb. *Hypericum petiolatum* Walt. Fl. Car. 191 (1788). Louisiana to Indiana, eastward to the coast as far north as New Jersey.

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Parke, Davis & Co.,

Detroit, Mich.

Notes on Birds of the Vicinity of Washington, Pennsylvania.*

BY DR. AND MRS. W. C. M'CLELLAND.

The observations that follow were chiefly made during the last ten years, 1911-1921. They give some brief account of bird behavior within an area probably less than a square mile in extent. This base, or locus observandi, includes a leafy suburb of Washington, Pa., valley land and hills, cultivated fields, a cemetery, gardens, orchards and woodland. The orchards are of old apple trees while the forests are deciduous, the white oak being the commonest tree, with varied often thick undergrowth. The elevation is from 1000 to 1400 feet, and the hillsides incline toward all the points of the compass. Latitude $40^{\circ}, 10''$; longitude 80° W.

The permanent bird residents we most often see or hear, summer and winter, include the cardinal grosbeak, the chickadee, the tufted tit, the downy woodpecker, the white-breasted nuthatch, the English sparrow, the song sparrow, the Carolina wren, the Bob-white and the screech owl.

Less common in winter, but often seen at other seasons, are the blue jay, the goldfinch, the red-bellied woodpecker, the cedar wax-wing, and the crow. The hairy woodpecker and the brown-breasted nuthatch though generally rated as permanent residents of Western Pennsylvania, are in our small district rather rare. The screech owl is occasionally heard.

A few robins, and some years a grackle or two, remain with us over winter. The winter wren, the tree sparrow, the brown creeper, the golden-crowned kinglet and in larger numbers the juncos are familiar visitors.

* Contribution from the Biological Laboratory, Washington and Jefferson College, No. 74.

Of familiar summer residents the robins begin to arrive in February; the grackles, the redwings and the bluebirds, early in March. A flicker has been noted February 24th, but usually this genuine harbinger of spring delays his coming until late in March. The mourning dove, reputed to be a permanent resident in our latitude, we have not seen earlier in the season than March 19.

The following according to our field notes, are dates of arrivals of other summer residents: towhee, March 19-23; field sparrow, March 17-25; Phoebe, March 15-25; sparrow hawk, March 19-23; chipping sparrow, April 3-10; brown thrasher, April 7-18; house wren, April 7-20; blue-gray gnat-catcher, April 15-21; yellow warbler, April 21-24; swift, April 15-30; wood thrush, April 25-May 1; catbird, April 26-May 4; Baltimore oriole, April 28-May 2; orchard oriole, April 28-May 4; warbling vireo, April 28-May 5; barn swallow, April 28-May 13; rose-breasted grosbeak, May 5-22; oven-bird, April 28-May 3; great crest, April 28-May 5; Maryland yellow-throat, May 17; redstart, May 8-15; chat, May 13-17; Acadian fly-catcher, May 10-21; indigo bunting, May 8-18; scarlet tanager, May 5-18; red-headed woodpecker, May 10-19; humming bird, May 8-20; purple martin, April 16-May 6; wood pewee and kingbird, May 8. The woodcock has been seen by us about the middle of May but possibly it is a permanent resident. It is not common.

The tardiest of our summer residents to arrive, as it seems to us, are the yellow-billed and the black-billed cuckoos. Usually they do not appear before the last days of May or the first week in June. The yellow-billed bird is the most often heard and seen.

Of the thrushes only the wood thrush nests in Western Pennsylvania. During the spring migration the hermit comes earliest, usually early in April; the veery, April 3-16; the olive-backed thrush seems not to reach our locality until late in May.

As is well known, most of the warblers are transients in and much beyond the field of our observations, only visiting us on their journeys north and south. In the spring they are arriving and departing from the last of April to the last of May in something like the following order: the myrtle, the

black and white, the Nashville, the northern water-thrush, the caerulean, the hooded, the chestnut-sided, the Kentucky the bay-breasted, the parula, the black-throated green, the black-throated blue, the mourning, the prairie, the Tennessee, the magnolia, the Cape May, the golden-winged, the Blackburnian, Wilson's, the black poll and the Canadian. At all events this is the showing of our observations.

Of transient sparrows we have noted the fox, the white-crowned and the white-throated; the fox sparrow appears early in April; the other two in May.

Both the night hawk and the whippoorwill we have seen and heard, but we have no record of their coming or going. Vesper and grasshopper sparrows, so far as our testimony goes, are summer residents arriving in April.

A few birds are seen by us not every year but at long intervals, the parula and the golden-winged warblers for example. The purple finch is reported as a winter visitor but we have seen it only now and then and always in the early spring. Once or twice only, bobolinks have delighted us by a visit of a few days in May to a nearby grassy hillside. A flock of crossbills have given us a single visit. Once a pleasant surprise came in the rare advent of six or eight evening grossbeaks, wanderers from the far Northwest. A single visit from a little green heron proved less exciting. Just once in many years have we heard the honking of wild geese flying north, or in any direction.

But these recalled the behavior of a representative of their family. When cannon were being fired one Fourth of July many years ago, our special observation was that at the sound of each explosion a swan would start like a frightened horse, whereas a Canada goose near it in the same pond showed no sign of disturbance. Once each a straggling mockingbird and a bewildered grebe have come our way.

Migratory birds are often said to return with great regularity. In confirmation of this we have noted the return of Baltimore orioles April 28th for three successive seasons. An orchard oriole put in a first spring appearance, alighting on a low bush near our breakfast room window at 7:30 one May day morning. The next year it was observed to return to the same bush on the same day and at the same hour precisely.

It may have been another male of the same species, but only one pair of these birds had been nesting in the neighborhood, nor did any other pair take up their abode with us that year.

In our vicinity the cardinal grosbeak has become suburban, building in the vines of porches of our own and our neighbors' houses. To the contrary, English sparrows have almost deserted our streets, since automobiles drop but little half-digested grain. Robins with us are abundant and seem to be increasing in numbers but the blackbirds, or bronze grackles, are by far the most numerous of our feathered populations. In September and October they are about us in imposing flocks that must contain hundreds of thousands of individuals.

Our bluebirds fluctuate greatly in numbers. Once they were not observed for two successive seasons. During their sometimes belated journeys south, violent, cold storms no doubt destroy many of them. The red-headed woodpecker appears of late to be growing very rare. We wonder if such locally new pests as the San José scale may injuriously affect its health. The red-eyed vireo is reported by some observers to be very common in Pennsylvania, but in our neighborhood, so far as our observations go, it is never seen. The warbling vireo is common. Purple martins and orchard orioles have apparently gone from us permanently; the former ousted by English sparrows, the latter disinherited by the felling of a thick-foliaged buckeye tree.

The list of birds that we have satisfactorily identified in our area includes about a hundred different species; the number of species seen each year varies from 75 to 85 according to our luck and diligence. Obviously our chances for the thrill of future discovery, even within the narrow confines of our avian territory, "just here about home," have not been exhausted.

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BOOK REVIEWS

In this section are reviews of new, or particularly important and interesting books in the fields of natural science. Books dealing with botany or kindred subjects should be sent to the Editor, the University of Notre Dame. *All other books for review* should be sent to Carroll Lane Fenton, at the Walker Museum, the University of Chicago, Ill. Publishers are requested to furnish prices with books.

PRINCIPLES OF ANIMAL BIOLOGY. By A. Franklin Shull. McGraw-Hill, Book Co. \$3.50.

It is a rare thing for anyone to write a textbook that is revolutionary in its material; it is still rarer for any one to produce a book that demands an entire revision of the teaching of a time-honored subject in natural science. For while we are willing to teach new material, we insist on teaching it the oldest way, and efforts looking toward a change are whole-heartedly discouraged.

But the teacher's worship of what is old seems to possess little weight with Dr. Shull and his associates. He has written a book that, if accepted, calls for an almost complete change in the teaching of zoology. Cutting, slicing, and peering through microscopes all have their place, but according to Dr. Shull, that place is far away from general courses in zoology. He believes that a general knowledge of the larger facts of zoology are more essential than a knowledge of the muscles of a frog's leg; that zoogeography deserves more space in a text than does taxonomy. He begins his work with a chapter on the general divisions of zoology, and a history of the science; he ends it with a glossary of the terms that students are apt to have difficulty with. Between those two chapters are others dealing with such subjects as the morphology of cells, the processes of cell division, physiology of organs, reproduction and breeding habits, embryology, genetics and evolution, ecology, and paleontology. Every chapter is complete in itself; it may be read as well separately as with the balance of the book. Together, these chapters make up a volume that is even more remarkable than Dr. Cockerell's "Zoology." The rebellion of Mr. Shull is complete; he strikes out for himself, and it must be acknowledged that he has gone a long distance. As I read his book I have but one regret—that I do not have the privilege of taking courses under its author's instruction.

C. L. F.

PARACELSUS. By John Maxson Stillman. The Open Court Co.

Theophrastus von Hohenheim, or as he is more commonly called, Paracelsus, illustrates well the independence, the self-confidence, the

boldness of thought, and the painful confusion of new and old that characterized the time of the later Renaissance. He was born the year following the discovery of America, and lived a life quite as stormy and almost as significant as that of the famed Columbus. The latter made a great discovery and brought about a great revolution in world affairs, industry, and politics; Paracelsus was a not less striking reformer in science, elementary medicine and chemistry.

Dr. Stillman's book is not offered as any new contribution to the history of a man who has been alternately praised and denounced for hundreds of years. It is a presentation in English of the essence of the long or relatively inaccessible German treatises, and papers, as well as a critical examination of attitudes and philosophy as shown in Paracelsus' own writings. The struggle with the antiquated medical men, the brief stay at the University in Basel, and the wanderings in various armies are presented only as a background for the later work of the revolutionary physician. The chemistry of Paracelsus is reviewed, and some space is devoted to the forged works that were for many years supposed to have antedated the great man's contested discoveries. But to the general reader, who must be considered along with the specialist in medicine, the early life of this reformer, his character and beliefs regarding his profession, and the manner in which he died are more interesting than his exact contributions to either medicine or chemistry. Most of us have known of him as a name; the biographical part of Mr. Stillman's book helps us to know of Paracelsus as a man.

C. L. F.

COMPANIONS, FEATHERED, FURRED, AND SCALED. By C. H. Donald, F. Z. S. John Lane Company. \$2.00.

Mr. Donald is one of those fortunate people who are able to "make friends" with birds and other animals of all sorts and dispositions. This ability, aided by a residence in India which allowed him to study first-hand the rich wild life of the Himalayas, has enabled him to write a book that is both interesting and instructive. Mr. Donald makes pets of his animals; he does not "train" them or shut them up in cages. Therefore his accounts have more value than mere comments on circus animals, or on those confined in zoological gardens.

The "companions" range from pythons to eagles; from monkeys to bears. And from the first chapter, telling the adventure of Bhaloo, a bear cub, to the last, which gives the life story of a little fox, the book is full of interesting natural history material. The numerous first-rate photographs of the animals which have at one time or another come into Mr. Donald's possession add much to the value of the book.

C. L. F.

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